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Extinct and endangered species in the vascular plant flora of Strzelce Opolskie (Southern Poland)

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ABSTRACT

Symptoms of anthropogenic changes in the vascular plant flora include the spread of some species groups and the extinction of others. Also habitat condition changes (eutrophication, pollution etc.) and biodiversity loss (at a regional, national and even continental scale) should be mentioned. Numerous papers with rare plant species localities and endangered habitats have been published but the extinction processes and scale of this phenomenon in urban areas where environmental conservation is crucial, are not often analysed. The aim of the present study is to estimate species loss in the vascular plant flora of the town Strzelce Opolskie (Chełm, Silesian Upland) on the basis of the floristic literature and botanical surveys carried out from 2011 to 2013. A comparison has been made between the list of species reported up to 1945 and those species currently occurring in the study area. As a result, a list of 99 species included in the red list of plants of Opole and Silesian voivodeships is presented. Among this group, 45 species are not confirmed after 1945. Numerous extinct and endangered species are from families: Orchidaceae (8 species), Cyperaceae (7 species), Ranunculaceae (7 species) and Lamiaceae (6 species). Strongly represented are species associated with the communities of *Festuco-Brometea* and *Querco-Fagetea* classes. From the species presented, 18 species are included in "Red List of Vascular Plants of Poland" (MIREK ET AL. 2006). It was found that the extinct species represent about 7% of Strzelce Opolskie vascular plant flora. It is a focus point for local authorities to protect botanically valuable areas. Actually, the only Miejski Park is under the conservator's protection and there are few individual trees protected due to their age or size.

KEY WORDS: flora, vascular plants, red list, Strzelce Opolskie, Silesia

1. Introduction

Analyses of extinction processes at the species level are a key issue to be examined by naturalists. Extinction is a natural process but in recent years it has increased rapidly as a result of human activities. Many native species are unable to fit into changing environments. They often show very high habitat specificity to particular biotic and abiotic elements of their environment. In the cultural landscape, urbanisation pressure is the main cause of species loss. As BRIGGS (2010) points, following the theory of natural selection, it is proposed that at each change in human land use, selection favours species having the highest Darwinian fitness (the so called winners) in that particular habitat, while other species of lesser fitness decline (the so called losers). At first, population size decreases, then the general number of localities becomes limited and at last species become extinct.

This paper is an attempt to estimate the changes in the vascular plant flora of Strzelce Opolskie - a town located in Chełm, a mesoregion of the Silesian Upland (Southern Poland) (KONDRACKI, 1988). Up to 1945, the major contribution to the floristic studies of this area were made by Germans. Among the botanists who worked on the local flora are WIMMER & GRABOWSKI (1827, 1829), WIMMER (1857), STENZEL (1876), FIEK (1881), SCHUBE (1903, 1904, 1911-1925), SCHALOW (1931, 1932). After The Second World War numerous papers with rare species localities were published (MICHALAK, 1963, 1976, 1981a,b; CIACIURA ET AL.,

1962; MĄDALSKI ET AL. 1963; SENDEK, 1965, 1971, 1989; SZOTKOWSKI, 1969; CELIŃSKI ET AL., 1974; CIACIURA & KOWAL, 1964). A notable monograph on the flora of the northern part of the Silesian Upland was published in 1974 by KOBIERSKI. In spite of numerous localities of rare and endangered species being given, the extinction processes were not analysed. It is worth noticing that since The War started, up to 1960's no botanical studies were carried out in study area. At the end of 20th century some essays at the national scales began to appear (ZARZYCKI, 1986; ZARZYCKI & SZELĄG, 1992; ZARZYCKI & KAŹMIERCZAKOWA, eds., 1993). Some of them have been re-edited in recent years (ZARZYCKI & KAŹMIERCZAKOWA, eds., 2001; ZARZYCKI & MIREK, 2006). Also regional scale red books (NOWAK & SPAŁEK, 2002) and lists of vascular plant species were issued (Opole voivodeship - NOWAK ET AL., 2008; Silesian voivodeship - PARUSEL & URBISZ, eds., 2012). Some valuable information about extinct, rare and endangered species of this region are given in KOZAK ET AL. (2005), URBISZ & URBISZ (2009), NOWAK (2011a,b), NOWAK ET AL. (2013).

The aim of the present a study is to estimate species loss in the vascular plant flora of the Strzelce Opolskie town, made on the basis of a comparison between the lists of species reported up to 1945 with those species currently occurring in the study area and compare the loss of species with other cities around the World.

2. Study area

Strzelce Opolskie (50°30' N; 18°17' W) is a district town located in the eastern part of Opole voivodeship (9412 km^2), southern Poland (Fig. 1). It occupies an area about 31 km^2 and is inhabited by more than 18,500 people (GUS, 2012). According to the division of Poland into physical-geographical regions (KONDRACKI, 1988), the town is located in the Chełm Ridge, a mesoregion of the Silesian Uplands.

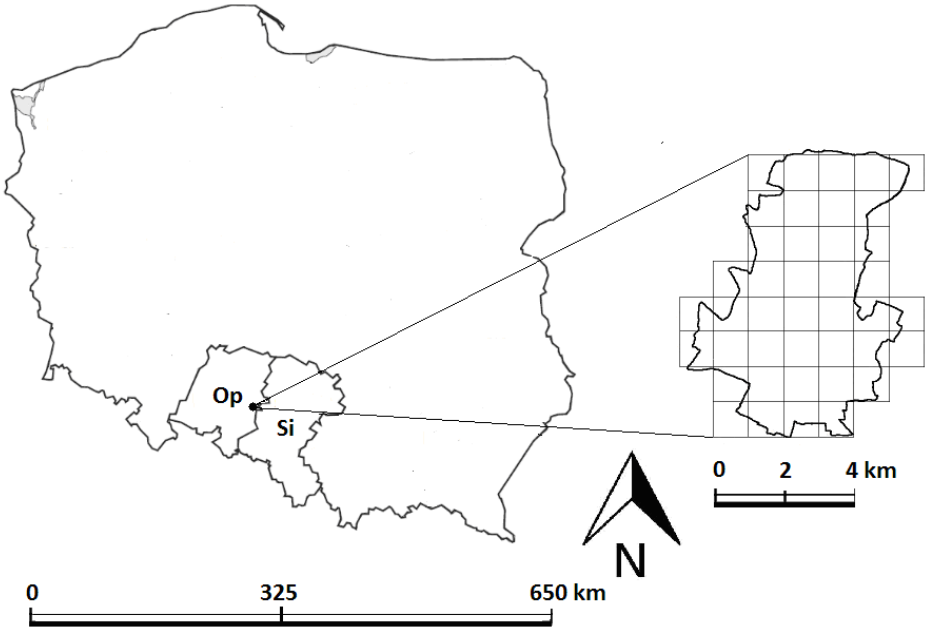

Fig. 1. Map of Strzelce Opolskie , situated in Opole voivodeship (Southern Poland) showing the 1-km grid and the city borders (Op – Opole voivodeship, Si – Silesian voivodeship)

Strzelce Opolskie originally developed from a trade village which appears to have been already mentioned in documents from the 17th century. The name of the town derived from a Prince's shooters (*strzelcy*) who hunted in this area. At that time, Strzelce Opolskie was inhabited by farmers cultivating mainly hops and vines and by craftsmen and traders (SMOLEŃ, 1998). In the second half of the 19th century, the town became a major centre for lime and for machinery industries (SZYMANKIEWICZ, 1994). It must be added that up to 1945 the study area was a part of Germany (*Groß Strehlitz, Oppeln Kreis*) and botanical studies were carried out only by local scientists, naturalists, teachers and apothecaries. Since the end of The Second World War the town is a part of The Republic of Poland.

The geological structure of the region, according to PAWLAK (1997) comprises of glacial and interglacial Quaternary sediments, Triassic limestone (Lower, Middle and Upper Triassic), dolomites and sandstones. In the soil cover of the town, rendzinas and brown soils can be distinguished. Rarely and at dispersed localities, organic - bog soils are found. The northern, forest

area is covered with pseudopodsoles. Locally in clays, luvisols have developed (SPAŁEK ET AL., 2007).

In the Strzelce Opolskie area average annual precipitation is about 680 mm and average annual temperature is +8.1°C. The climate is heavily influenced by geographical location, distribution of water-bodies, terrain and type of plant cover (SPAŁEK ET AL., 2007). In terms of meso- and topoclimate, conditions in the study area are harsher than in the central part of Opole voivodeship. This is associated with its location on the edge of the Silesian Upland (PAWLAK, 1997).

Within the administrative boundaries of the town, the river system has almost completely disappeared due to karst processes. There is an outflow directly into the Triassic limestone rock mass. In Strzelce Opolskie there are only anthropogenic water-bodies – the Rybaczówka Lake, ponds in the Park Miejski, reservoirs in limestone quarries and for industrial water treatment.

3. Materials & methods

A list of extinct, rare and endangered species was prepared on the basis of floristic papers (FIEK, 1881; SCHUBE, 1903, 1904, 1919; BRZEZAK, 1928; SCHALOW, 1932; MICHALAK, 1963, 1976, 1981a; KOBIERSKI, 1974; CIACIURA & KOWAL, 1974; DAJDOK ET AL., 1998; KOZAK ET AL., 2005; NOWAK, 2005; SPAŁEK ET AL., 2007) and from a field study carried out in 2011-2013 within the administrative boundaries of Strzelce Opolskie. The presence of vascular plant species was recorded systematically within the defined 1 km^2 grid-cells according to a system proposed in "Distribution Atlas of Vascular Plants in Poland - ATPOL" (ZAJĄC & ZAJĄC, 2001). The localities obtained from historical flora lists are not precise and there are no available standardisations to be made (spatial resolution, sampling or inventory methods are not satisfactorily presented).

Species threat categories follow "The Red List of Vascular Plants of Opole Province" (NOWAK ET AL., 2008) and "The Red List of Vascular Plant of Silesian voivodeship" (PARUSEL & URBISZ, eds., 2012).

Species were ranked according to decreasing threat category, starting with extinct species. Separate lists of species confirmed and unconfirmed after 1945 were prepared. A list of species included in the red list of the Silesian voivodeship but not included in the analogous list from Opole voivodeship was prepared. Nomenclature of species follows "Flowering plants and pteridophytes of Poland. A checklist". (MIREK ET AL., 2002). Phytosociological affiliation was adapted from MATUSZKIEWICZ (2008) and ZARZYCKI ET AL. (2002). The differences between threat categories of the presented species in Opole and Silesian voivodeships and the phyto-sociological spectrum of species classified into each category were prepared as histograms.

4. Results

During field studies carried out in 2011-2013 seasons 519 native vascular plant species and established alien plant species (antropophytes) were recorded. A spatial variation in species number within grid cells is shown in Figure 2.

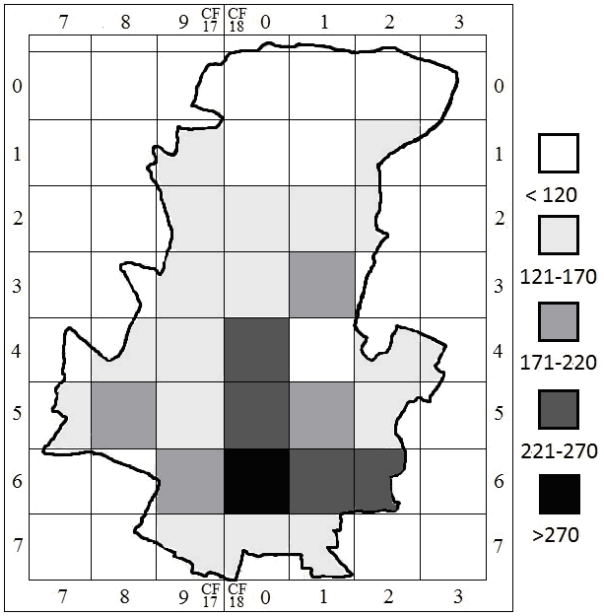

Fig. 2. A spatial variation in number of species within grid cells

In the vascular plant flora of Strzelce Opolskie 45 species have not been confirmed since 1945 (Tab. 1). Among the unconfirmed species there are 6 which are considered to be extinct, 9 critically endangered, 12 endangered, 10 vulnerable, 4 near threatened and 2 species with least concern category in the Opole voivodeship. Another 2 species were not included in the red list of plants of Opole voivodeship.

The next group includes 54 vascular plant species for which occurrence in Strzelce Opolskie has been confirmed since 1945. Among this species, 14 were not included in the red list of vascular plants of Opole voivodeship but were included in the Silesian one (Tab. 2).

In total, of the 99 species placed in the red lists of Opole and Silesian voivodeships which were recorded in Strzelce Opolskie, 45 have not been confirmed since 1945. Most of extinct and endangered species belong to families: Orchidaceae (8 species), Cyperaceae (7 species), Ranunculaceae (7 species) and Lamiaceae (6 species).

In Figure 3 the phytosociological affiliation of species belonging to particular threat categories in Opole voivodeship is given. Strongly represented are species associated with the communities of *Festuco-Brometea* and *Querco-Fagetea* classes (18 species per class). Comparison of the number of species classified into particular threat categories between Opole and Silesian voivodeships is presented in Figure 4. The number of locally extinct species in both regions is the same. In the Opole voivodeship more species are considered critically endangered and endangered but in the Silesian voivodeship larger numbers are representative of groups of vulnerable, near threatened and least concern species. Also for further species the available data is insufficient.

Table 1. Species not confirmed after 1945 in Strzelce Opolskie

Species	Record authors	Threat category		Syntaxon
		Op	Si	
Minuartia viscosa	SCHUBE, 1904	RE	RE	*Kg.- Cc.*
Pulsatilla vernalis	BRZEZAK, 1928	RE	RE	*Ses. var.*
Cyperus flavescens	SCHUBE, 1904	RE	CR	*Is.- Nan.*
Goodyera repens	SCHUBE, 1904	RE	CR	*Vac.- Pic.*
Tofieldia calyculata	SCHUBE, 1904	RE	EN	*Sch.- Car.*
Nonnea pulla	MICHALAK, 1976	RE	VU	*Fest.- Brom.*
** Ajuga chamaepitys*	SCHUBE, 1904	CR	RE	*Stel. med.*
Botrychium matricariifolium	SCHUBE, 1904	CR	EN	*Nar.- Cal.*
Diphasiastrum complanatum	SCHUBE, 1904	CR	EN	*Vac - Pic.*
** Nigella arvensis*	FIEK, 1881; SCHUBE, 1904	CR	EN	*Stel. med.*
Botrychium lunaria	SCHUBE, 1904	CR	VU	*Nar.- Cal.*
Cephalanthera rubra	SCHUBE, 1904	CR	VU	*Q.- Fag.*
Corallorhiza trifida	SCHUBE, 1904	CR	VU	*Vac.- Pic.*
Platanthera chlorantha	SCHUBE, 1904	CR	VU	*Q.- Fag.*
Viola mirabilis	SCHUBE, 1904	CR	VU	*Q.- Fag.*
Asperula tinctoria	SCHUBE, 1904	EN	RE	*Fest.- Brom.*
Senecio congestus	SCHUBE, 1904	EN	RE	*Phrag.*
** Anagallis foemina*	SCHUBE, 1904	EN	EN	*Stel. med.*
Lycopodiella inundata	SCHUBE, 1904	EN	EN	*Sch.- Car.*
Potentilla alba	SCHUBE, 1904	EN	EN	*Q.- Fag.*
Dactylorrhiza incarnata	SCHUBE, 1904	EN	VU	*Sch.- Car.*
Hypochoeris maculata	SCHUBE, 1904	EN	VU	*Fest.- Brom.*
Potentilla recta	SCHUBE, 1903	EN	VU	*Fest.- Brom.*
Aquilegia vulgaris	SCHUBE, 1903, 1904	EN	NT	*Q.- Fag.*
Thalictrum minus	FIEK, 1881	EN	NT	*Tri.- Ger.s.*
Thalictrum aquilegiifolium	SCHUBE, 1919	EN	NT	*Bet.- Ad.*
Pulmonaria angustifolia	SCHUBE, 1904	EN	DD	*Q.- Fag.*
Scabiosa canescens	SCHUBE, 1903, 1904	VU	RE	*Fest.- Brom.*
Vicia lathyroides	SCHALOW, 1932	VU	EN	*Kg.-Cc.*
Cephalanthera damasonium	SCHUBE, 1904	VU	VU	*Q.- Fag.*
Cephalanthera longifolia	SCHUBE, 1904	VU	VU	*Q.- Fag.*
Juncus alpino-articulatus	SCHUBE, 1904	VU	VU	*Sch.- Car.*
Ophioglossum vulgatum	SCHUBE, 1904	VU	VU	*Mol.-Ar.*
Teucrium botrys	SCHUBE, 1904	VU	VU	*Fest.- Brom.*
Veratrum lobelianum	SCHUBE, 1904	VU	NT	*Bet.- Ad.*
Agrimonia procera	SCHUBE, 1904	VU	LC	*Tri.- Ger.s.*
Carex pairae	SCHUBE, 1904	VU	DD	*Epil.ang.*
Carex appropinquata	SCHUBE, 1904	NT	VU	*Phrag.*
Circaea intermedia	SCHUBE, 1904	NT	VU	*Q.- Fag.*
Potamogeton alpinus	SCHUBE, 1904	NT	VU	*Pot.*
Cardamine impatiens	SCHUBE, 1904	NT	LC	*Art. vul.*
Melica uniflora	SCHUBE, 1904	LC	VU	*Q.- Fag.*
Lilium martagon	SCHUBE, 1904	LC	NT	*Q.- Fag.*
** Parietaria officinalis*	SCHUBE, 1904	-	CR	*Art. vul.*
Astragalus cicer	SCHUBE, 1904	-	VU	*Tri.- Ger.s.*

Key to abbreviations in Tables 1-3: * - archaeophytes; **Art.vul**. - *Artemisietea vulgaris*; **Asp.rup**. - *Asplenietea rupestris*; **Bet.-Ad**. - *Betulo-Adenostyletea*; **Epil.ang**. - *Epilobietea angustifolii*; **Fest.-Brom.** - *Festuco-Brometea*; **Is.-Nan**. - *Isöeto-Nanojuncetea;* **Kg.-Cc**. - *Koelerio glaucae-Corynephoretea canescentis*; **Mol.-Ar**. - *Molinio-Arrhenatheretea*; **Nar.-Cal**. - *Nardo-Callunetea*; **Phr.** - *Phragmitetea*; **Pot.** - *Potametea*; **Q.-Fag**. - *Querco-Fagetea*; **Ses.var**. - *Seslerietea variae*; **Sch.-Car**. - *Scheuchzerio-Caricetea nigrae;* **Stel. med**. - *Stellarietea mediae*; **Tri.-Ger.s**. - *Trifolio-Geranietea sanguinei*; **Vac.-Pic**. - *Vaccinio-Piceetea;* **CR** - critically endangered; **DD** – insufficient data; **EN** - endangered; **LC** - least concern; **NT** - near threatened; **RE** - regionally extinct; **VU** - vulnerable; **DD** - data deficient; **Op** - Opole voivodeship; **Si** - Silesian voivodeship

Table 2. Species confirmed after 1945 in Strzelce Opolskie (see abbreviation key for Table 1)

Species	Record authors	Threat category		Syntaxon
		Op	Si	
Gentianella cilliata	DAJDOK ET AL., 1998	CR	VU	*Fest.- Brom.*
Jovibarba sobolifera	DAJDOK ET AL., 1998	CR	VU	*Kg.- Cc.*
Prunella grandiflora	SPAŁEK ET AL., 2007	CR	NT	*Fest.- Brom.*
** Camelina sativa*	KOBIERSKI, 1974	EN	EN	*Stel. med.*
Scabiosa columbaria	KOBIERSKI, 1974	EN	EN	*Fest.- Brom.*
Galium saxatile	MICHALAK, 1963	EN	VU	*Nar.- Cal.*
Inula conyza	MICHALAK, 1981A	EN	VU	*Tri.- Ger.s.*
Koeleria macrantha	SPAŁEK ET AL., 2007	EN	VU	*Fest.- Brom.*
** Bromus secalinus*	FOLCIK, 2013	EN	NT	*Stel. med.*
Knautia dipsacifolia	CIACIURA & KOWAL, 1974	EN	DD	*Tri.- Ger.s.*
Nasturtium officinale	SPAŁEK ET AL., 2007	VU	EN	*Phrag.*
Schoenoplectus tabernaemontani	NOWAK, 2005	VU	EN	*Phrag.*
Zannichelia palustris	KOZAK ET AL., 2005	VU	EN	*Pot.*
Cyperus fuscus	KOZAK ET AL., 2005	VU	VU	*Is.-Nan.*
Eleocharis ovata	KOZAK ET AL., 2005	VU	VU	*Is.-Nan.*
Equisetum variegatum	SPAŁEK ET AL., 2007	VU	VU	*Sch.- Car.*
Gymnocarpium dryopteris	SPAŁEK ET AL., 2007	VU	VU	*Q.- Fag.*
Melittis melisophyllum	KOBIERSKI, 1974	VU	VU	*Q.- Fag.*
Asperula cynanchica	KOBIERSKI, 1974	VU	NT	*Fest.- Brom.*
Geranium sylvaticum	FOLCIK, 2013	VU	NT	*Bet.- Ad.*
Hypericum humifusum	FOLCIK, 2013	VU	NT	*Is.- Nan.*
Melampyrum arvense	SPAŁEK ET AL., 2007	VU	NT	*Fest.- Brom.*
Nymphaea alba	FOLCIK, 2013	VU	NT	*Pot.*
Orobanche lutea	SPAŁEK ET AL., 2007	VU	NT	*Fest.- Brom.*
Viola collina	KOBIERSKI, 1974	VU	NT	*Q.- Fag.*
Geranium phaeum	FOLCIK, 2013	VU	LC	*Q.- Fag.*
Achillea pannonica	FOLCIK, 2013	VU	DD	*Fest.- Brom.*
Festuca rupicola	SPAŁEK ET AL., 2007	VU	DD	*Fest.- Brom.*
Euphorbia exigua	KOBIERSKI, 1974	NT	VU	*Stel. med.*
Anthericum ramosum	SPAŁEK ET AL., 2007	NT	NT	*Tri.- Ger.s.*
Astrantia major	KOBIERSKI, 1974	NT	LC	*Q.- Fag.*
Dactylorrhiza majalis	FOLCIK, 2013	NT	LC	*Mol.- Ar.*
Salvia pratensis	KOBIERSKI, 1974	NT	LC	*Fest.- Brom.*
Hottonia palustris	MICHALAK, 1963	LC	VU	*Pot.*
Ajuga genevensis	SPAŁEK ET AL., 2007	LC	NT	*Fest.- Brom.*
Actaea spicata	KOBIERSKI, 1974	LC	LC	*Q.- Fag.*
Isopyrum thalictroides	FOLCIK, 2013	LC	LC	*Q.- Fag.*
Orthilia secunda	FOLCIK, 2013	LC	LC	*Vac.- Pic.*
Polypodium vulgare	SPAŁEK ET AL., 2007	LC	LC	*Asp. rup.*
Carex hartmanii	FOLCIK, 2013	DD	DD	*Mol.- Ar.*
Galega officinalis	FOLCIK, 2013	-	EN	*Mol.- Ar.*
Rorippa austriaca	FOLCIK, 2013	-	VU	*Mol.- Ar.*
Saxifraga granulata	FOLCIK, 2013	-	VU	*Mol.- Ar.*
** Veronica agrestis*	CIACIURA & KOWAL, 1964	-	VU	*Stel. med.*
Anemone ranunculoides	FOLCIK, 2013	-	NT	*Q.- Fag.*
Corydalis cava	FOLCIK, 2013	-	NT	*Q.- Fag.*
Nuphar lutea .	FOLCIK, 2013	-	NT	*Pot.*
** Valerianella dentata*	FOLCIK, 2013	-	NT	*Stel. med.*
Anchusa arvensis	FOLCIK, 2013	-	LC	*Art. vul.*
Ceratophyllum demersum .	FOLCIK, 2013	-	LC	*Pot.*
Gagea lutea	FOLCIK, 2013	-	LC	*Q.- Fag.*
Myriophyllum spicatum	FOLCIK, 2013	-	LC	*Pot.*
Potentilla neumanniana	FOLCIK, 2013	-	LC	*Fest.- Brom.*
Carex demissa	FOLCIK, 2013	-	DD	*Sch.- Car.*

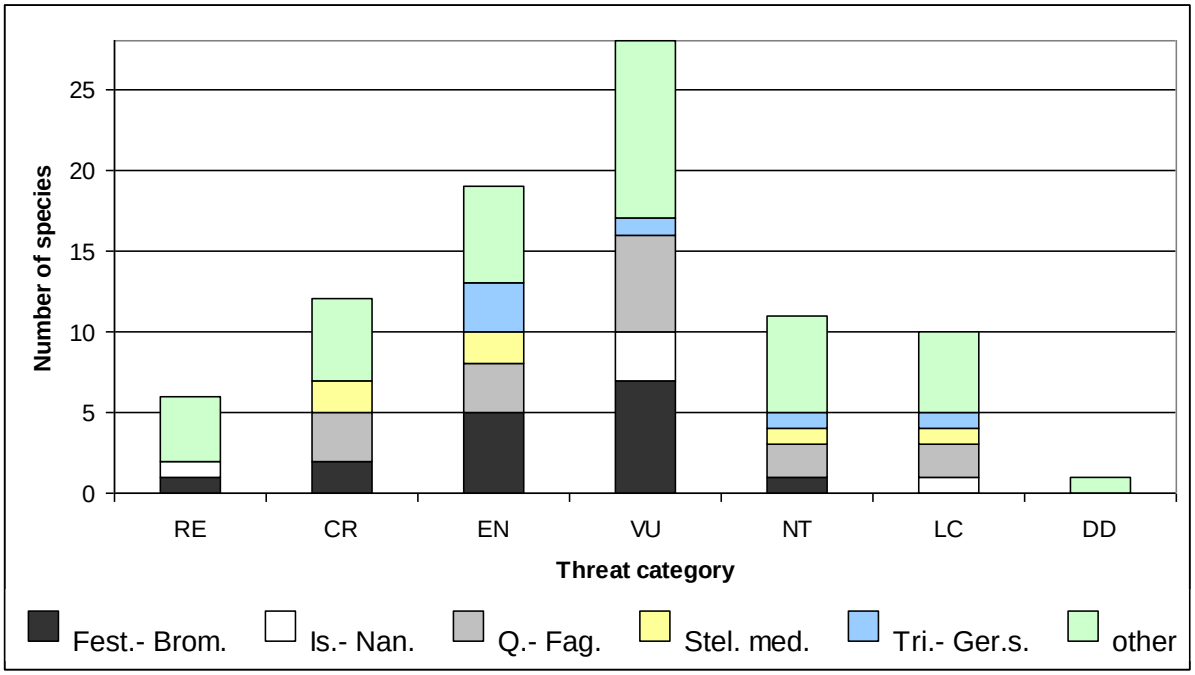

Fig. 3. Phytosociological affiliation of species assigned to a particular threat category in Opole voivodeship (see abbreviation key for Table 1)

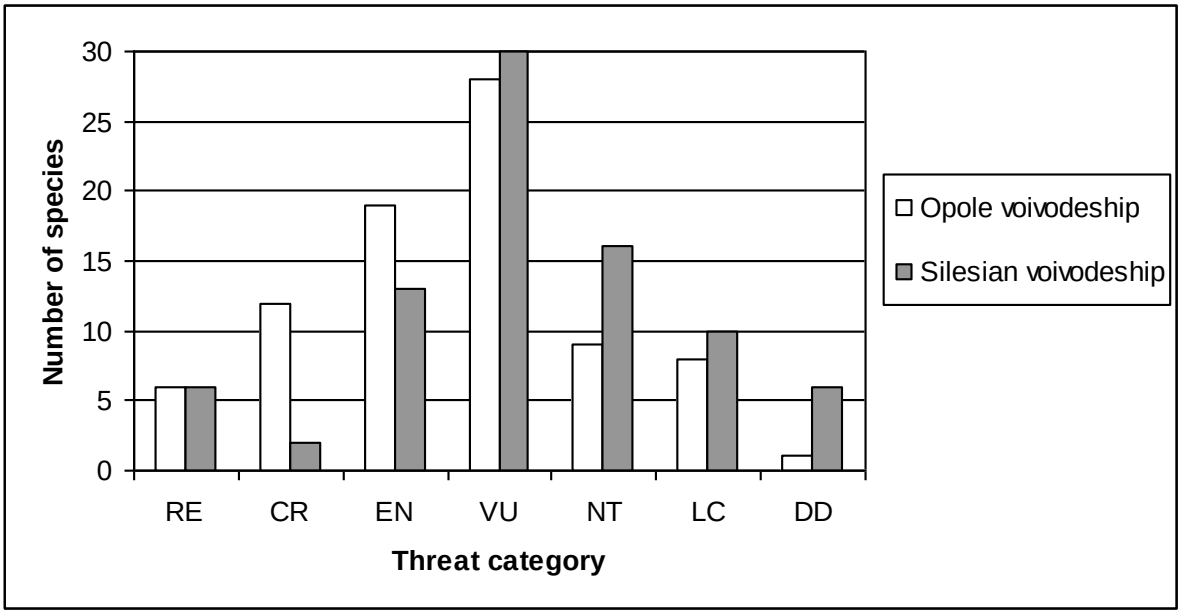

Fig. 4. Comparison between number of species recorded in Strzelce Opolskie from red lists of vascular plants of Opole and Silesian voivodeships (see abbreviations key for Table 1)

5. Discussion

Within the administrative boundaries of Strzelce Opolskie, 45 species, representing 7.1% of the permanently established flora were not confirmed (Tab. 1). This result is comparable with that obtained for Rybnik in another study (42 species unconfirmed after 1945, i.e. 4% of permanently established flora – URBISZ & URBISZ, 2003). A nearly threefold larger number of species have not been confirmed in Poznań (124 unconfirmed after 1951 which is 11.6% of total flora – JACKOWIAK, 1990). This is mainly because of the larger area that this city occupies. Some interesting analyses of extinction rate in worldwide urban environments have been published (HAHS ET AL., 2009; DUNCAN ET AL., 2011). Authors indicate the number of extinct and extant species together with a length of investigations of flora of the examined cities (Tab. 3).

Among the extinct and endangered vascular plant species in Opole voivodeship, 18 species are included in the "Red List of Vascular Plants of Poland" (MIREK ET AL., 2006). Vulnerable species (category V) are represented by *Ajuga chamaepitys, Anagallis foemina, Asperula tinctoria, Botrychium lunaria, B. matricariifolium, Bromus secalinus, Cephalanthera*

damasonium, C. longifolia, C. rubra, Corallorhiza trifida, Cyperus flavescens, Eleocharis ovata, Lycopodiella inundata, Ophioglossum vulgatum and *Potamogeton alpinus.* A species in danger of extinction in isolated localities (category [V]) is *Tofieldia calyculata.* Becoming extinct and critically endangered at a national scale (category E) is *Botrychium matricariifolium. Goodyera repens* is considered critically endangered in isolated localities (category [E]). The most numerous endangered species in Poland are orchids and pteridophytes (MIREK ET AL., 2006). The threat of these groups is mainly in situations with decisive modifications or disappearance of characteristic habitats where there is specific adaptation biology.

Table 3. The number of native species that became locally extinct in the study period and the number of native species that persisted (extant) in the given cities (see abbreviation key for Table 1)

City	Locally extinct species	Extant native species	Species loss %	Study length	Source
Adelaide	81	964	8.4	166	TAIT ET AL., 2005
Auckland	80	293	27.3	114	DUNCAN & YOUNG, 2000
Singapore	598	1578	37.9	c. 100	CHONG ET AL., 2009
New York	401	1159	34.5	207	CORLETT ET AL., 2000
Worcester, MA	174	644	27	c. 100	BERTIN, 2002

The extinct and endangered species of the Strzelce Opolskie vascular plant flora are most commonly associated with communities belonging to *Festuco-Brometea* and *Querco-Fagetea* (especially *Cephalanthero-Fagenion* suballiance) classes. In the study area these phytocoenoses have almost completely disappeared. The neglect, change and abandonment of a whole array of traditional practices is the main cause of the disappearance of calcareous grasslands. Some of them have probably been overgrown by trees and shrubs which has a dramatic effect on specific species combinations. Calcareous grasslands and beech forests of Strzelce Opolskie could have originally constituted a large complex with phytocoenoses extant within the Chełm Rigde centre, where some nature reserves have been established (e.g. Ligota Dolna – 1959, Góra św. Anny – 1972, Boże Oko – 1997, Biesiec – 2001 and others). Forest communities, especially the so-called beech-orchid forests, have probably undergone a complete deforestation and their habitats are now occupied by pine monocultures and arable land.

In comparison with the Silesian voivodeship, in the Opole region more species are considered critically endangered and endangered but less are classified as vulnerable, near threatened or of least concern. Among the species analysed, 23 (27.7%) belong to the same threat category, 16 (19.3%) are at higher risk in the Silesian and 44 (53%) in the Opole voivodeship.

In Opole voivodeship 16 species are not included in the red list of vascular plant species, but they are listed in a similar work compiled for the neighboring Silesian voivodeship (Tab. 3.) Due to the short distance and the lack of any ecological barriers between these regions, it can be concluded with high probability that this group of species had been overlooked and some of them have not been precisely recognised in the face of taxonomic difficulties.

The number of native species and the so-called archaeophytes (i.e. naturalised alien plant species introduced before 1500) found in urban areas is clearly declining. Species considered probably extinct are only a small percentage of the spontaneous town flora. However, these are approximate values which are highly influenced by the particular impact on land use within the town area and the intensity of floristic research.

Within administrative boundaries of Strzelce Opolskie, the only Miejski Park is under the conservator's protection and there are few individual trees protected due to their age or size. Another several taxa protected by Polish Nature Conservation Act can be found. The local authorities should take a positive action in restoring native vegetation in the landscape of the town. There is need to improve management of the remaining native vegetation with emphasis on spatial management, leading to maximise proportion of native species and minimise the isolation of rare and endangered plant species populations. It is worth protecting some small populations of plants in urban areas. These populations are always destined for rapid extinction.

National environmental protection policy should not be only focused on the particular, natural types of plant communities (e.g. alpine grasslands) or groups of species (e.g. orchids). The species loss in urban areas should be examined more precisely in terms of the rate, environmental determinants and human practices leading to improvement of the biodiversity of city flora.

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